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minating. An infinite terminating ordinal, a, can be expressed uniquely as a sum $a' + n$ where n is finite, and a' is nonterminating. The finite term n is called the *termination* of a. In any product ab, where a is terminating with termination, n, the product will be terminating and have this same termination n, for every terminating b, although this termination, which is independent of the character of b so long as b is terminating, vanishes whenever b is nonterminating.

In the expression $a - b$, let l denote the lesser of the two quantities a, b, and d denote their difference. Then $a - b$ may be written $l \pm d - l$, where $\pm d$ is called the *stem*, and l, the *affix* of the expression, $a - b$. The sign of $\pm d$ depends upon the particular expression $a - b$ considered and is completely determined except for the trivial case where $d = 0$. The product $(l \pm d - l)c$ is defined as $l \pm dc - l$ when c is terminating, and as $\pm dc$ when c is nonterminating. For example

$$(\omega - 3)(\omega^2 + \omega2 + 7) = 3 + \omega(\omega^2 + \omega2 + 7) - 3 = \omega^3 + \omega^2 2 + \omega7 - 3$$

$$(\omega - 3)(\omega^2 + \omega2) = \omega(\omega^2 + \omega2) = \omega^3 + \omega^2 2$$

$$((\omega + 1) - 4)(\omega^2 + \omega2 + 7) = 4 + (\omega + 1)(\omega^2 + \omega2 + 7) - 4$$

$$= \omega^3 + \omega^2 2 + \omega7 + 1 - 4$$

$$((\omega + 1) - 4)(\omega^2 + \omega2) = (\omega + 1)(\omega^2 + \omega2) = \omega^3 + \omega^2 2$$

The above rule has the desirable though not essential property that if we identify $a - b$ and $(a + n) - (b + n)$, then we may also identify $(a - b)c$ with $((a + n) - (b + n))c$, where n is a finite ordinal. Thus so far as finite ordinals are concerned we may if we desire regard $n - n$ as identical with zero, although this is not desirable in some applications.

The product $(a_1 - b_1)(a_2 - b_2)$ is defined as $(a_1 - b_1)a_2 + (b_1 - a_1)b_2$. The product $(a_1 - b_1)((a_2 - b_2) + (a_3 - b_3))$ is found to be equal to $(a_1 - b_1)(a_2 - b_2) + (a_1 - b_1)(a_3 - b_3)$ if the stem of $a_1 - b_1$ is positive. In case this stem is negative, we have instead $(a_1 - b_1)(a_3 - b_3) + (a_1 - b_1)(a_2 - b_2)$, as is to be expected.

It is to be noted that the above is closely suggestive of the process by which rational fractions are introduced in the development of the number system by means of pairs of integers.

AMONG MY AUTOGRAPHS.

By DAVID EUGENE SMITH, Columbia University.

14. MAUPERTUIS AND FREDERICK THE GREAT.

Among those whom Frederick the Great called to his court for the purpose of accomplishing what the Ptolemies had done for Alexandria, the caliphs for Bagdad, and the Medici for Florence, there were a few scientists and literati of genius, and still more of near ability. Of the latter, Maupertuis is perhaps the

best known.   He was born at St. Malo in 1698, and, after falling from royal
favor, died at Basel in 1759.   He spent six months in England, in 1728, while
Voltaire was there, and during this time was made a member of the Royal Society
and became familiar with the Newtonian theory.   In 1740 he was made president
of the Berlin Academy, Frederick saying that it should be formed "as you alone
can form it."   A biographer of Voltaire thus writes of him:

"Precise, pompous, and positive; boring society with his worrying exactness
upon trifles even more than society bored him; inordinately vain, and with a
sensitive temper made yet more inflammable by brandy and self love; acutely
conscious of his dignity, and without any sense of humor, the ex-tutor of Madame
Châtelet was the sort of person with whom, sooner or later, her lover [Voltaire]
was sure to disagree."

The quarrel broke soon after Voltaire reached Berlin, in 1750.   It arose over
a vacancy in the Academy, Maupertuis favoring Jean-Baptiste de Boyer, Marquis
d'Argens, an oriental scholar, while Voltaire urged Raynal, the philosopher and
historian.   It was a bitter one and ended in each vanquishing the other so far
as the court of Potsdam was concerned.

I have two holograph letters of Maupertuis relating to his sojourn in Potsdam.
The first was written to Frederick the Great, and may some time find place in this
series.   The second was written when the royal favor was not so apparent.
Voltaire's sarcasm had begun to have its effect.   The letter is dated simply
"Tuesday the 14th," which does not allow us to fix the year, and is full of appre-
hension as to the effect of certain remarks, doubtless Voltaire's, which had been
quoted against him.   The writing is indistinct in several places, and I am indebted
to my colleague, Professor Méras, for assistance in arriving at the meaning,
but the letter reads substantially as follows:

You have not told me a single word about the effect produced at Potsdam by the letter of my
generous and sublime defender.   It has the approbation of all honest people here, and of all those
who have position and taste.

Someone brought me *Le Tombeau de la Sorbonne*, and I am still at it.   It is very interesting,
but in order to amuse [?] the malignity of the readers they have made it lose all air of truth.

I do not see that Walther has answered you on the subject of the books which I requested
you to ask of him.   You had also promised to send me the Latin thesis on the generation of organic
beings which I received from Erlangen and which I sent you at the request of Buffon.   I should
very much like to have it back again.

Adieu, my dear friend.   I think that glory is not destined for me so much as criticism, for
I am less accustomed to it. . . .

    I am always yours,

                                      MAUPERTUIS.

Maupertuis refers to the Erlangen dissertation in his *Œuvres* (1768 edition,
II, 187) and to Diderot's comment upon it. · Those were days of anonymous
pamphlets and of pseudonyms, and this reference illustrates the situation.   The
thesis was, as a matter of fact, the work of Maupertuis himself, although he speaks
of it as the *Dissertatio inauguralis metaphysica de universali Naturae systemate*,
and as the work of one Dr. Baumann.

The letter marks the period of the beginning of the decline of Maupertuis

at the court of Frederick.   He had recently published (1752) his *Lettres*, a small volume on all sorts of schemes and things, some absurd and others trivial.   Voltaire said that Maupertuis had previously been in a lunatic asylum and was still crazy.   But Frederick, beginning to feel the danger of Voltaire's intimacy, took the part of Maupertuis and, on November 5, 1752, congratulated him upon his performance.   It seems probable that the letter refers to this fact.

Frederick's statement was a challenge to Voltaire, and he accepted it.   The result was the *Diatribe of Doctor Akakia,* one of the keenest satires in the French language.   "I have no scepter," wrote Voltaire, "but I have a pen."   It is said that Frederick laughed till he cried over the castigation of poor Maupertuis.   He loved wit more than science, or pseudo-science, or friendship.

In the second edition of his *Lettres* Maupertuis records the official burning of the *Diatribe;* "Le Libelle fut brûlé le 24 Décembre 1752, publiquement, par le main du Bourreau, dans toutes les places de Berlin."   In that delightful *Life of Voltaire* by Tallentyre, the story is told of how his secretary, Collini, seeing the crowd and watching the bonfire, mentioned the circumstance to the "old invalid of Ferney."   "I'll bet it's my Doctor!" said Voltaire,—and he was right.

15. THE PARADOXER AND DEPARCIEUX.

Antoine Deparcieux. (to adopt his own spelling) was one of the leaders among the scholars of France who devoted their attention to applied mathematics in the middle of the eighteenth century.   He was born at the little hamlet of Cessoux (Gard), near Nîmes, October 8, 1703, and died at Paris on September 2, 1768. At the age of forty-three he was admitted to the Academy of Sciences, and between 1740 and 1768 became recognized as one of the distinguished group of French savants.   He wrote on trigonometry, probabilities as applied to mortality tables, and astronomy, and received numerous honors abroad as well as in his native land.

Like all mathematicians or teachers occupying positions which tend to make them known, Deparcieux was bored by that class of men about whom De Morgan wrote so delightfully in his *Budget of Paradoxes*.   It is interesting to see how such a man received the suggestions of the half-demented correspondents who felt that they had solved the Fermat Theorem, squared the circle, untangled the mystery of the Hindu-Arabic numerals, or overturned the Newtonian theory.

One of the letters of Deparcieux in my collection is a reply to a communication from a certain M. Fomaigne who had discovered a "new government of the sun." The letter shows Deparcieux entering into the spirit of the argument, and indulging in some interesting bits of sarcasm.   It reads in part as follows:

COMPIÈGNE, May 18, 1758.

Monsieur:

I have read the annexed memoir which informs us of a new government (nouveau gouvernement) of the sun, and of which it is difficult to understand a single thing.   It seems, however, like an effort to prepare a set of tables of the rising and setting of the sun which shall be more exact than those now in use.   It looks as if you wished to accomplish this by means of a certain line drawn on two sun dials, one oriental and the other occidental, or on a single one.   If the Sieur Fomaigne had read anything on the subject he would surely express himself somewhat differently,

would probably have seen the matter in a different light, would know that tables of extreme accuracy already exist, and would recognize that the line which can represent different kinds of the rising of the sun (for there is one) starts from the same source. What he says about the moon has no common sense. He wishes to govern the moon, but if he is not crazy he will see that it is the moon which governs the sun.

The letter is evidently intended to follow the style and spirit of the memoir, and to run into a state of semi-aberration of mind,—a procedure which renders a translation difficult. Nevertheless it closes with the usual politeness of the Parisian:

I have the honor of being, with the most profound respect and the most sincere attachment, Monsieur, your humble and very obedient servant,

DEPARCIEUX.

One lesson we can learn from Deparcieux's letters,—namely,—that it is never necessary to punctuate. In the letter referred to there are only two marks of punctuation in three quarto pages, and in another of his letters before me there are only three,—a period and two commas.

16. A LETTER OF GASSENDI'S WRITTEN IN 1633.

Although Pierre Gassendi was best known for his work in astronomy, he was one of the brilliant circle of mathematicians which was making France the scientific center of the world in the first half of the seventeenth century. He has been called the first French disciple of Bacon, the worthy friend of Galileo and Kepler, and the precursor of Newton and Locke. He was born near Digne, in Provence, on January 22, 1592, and is one of the few infant prodigies who ever attained any eminence. He was only twenty-one when he was called to the chair of philosophy as well as to that of theology in the University of Aix. He accepted the latter, but in 1623 he resigned from his professorial duties in order to devote his time to study and travel. He visited and taught in Paris, traveled in the Low Countries, and met with many savants, such as Descartes, Mydorge, Mersenne, and Cassini I, and made friendships which lasted throughout his life. His writings cover a wide field and include works on philosophy, astronomy, theology, physics, and the calendar.

Among my autographs is a letter written from his old home at Digne, on August 2, 1633. It is addressed to "Monsieur de Peiresc, abbe & seig^n de Guistre, Con^r du Roy,"—then a king's counsellor in the local "parlement" of Aix. Nicolas-Claude Fabri de Peiresc, like Gassendi a native of Provence, was twelve years the senior of the latter. He was one of those fortunate men who establish strong bonds of friendship with scholars, and among his intimate correspondents were some of the most learned men of his time. He was a botanist, a linguist, a physiologist, a historian, and a lover of books. Louis XIII gave to him the abbey of Notre-Dame at Guistre, in the diocese of Bordeaux, and it was to him as abbot that Gassendi wrote this letter. Four years later, on June 24, 1637, he died in Gassendi's arms.

The letter is one of those which were beginning to be interchanged so freely at that time among the members of the mathematical fraternity, and offers

evidence of the nature of the work in which mathematicians and astronomers had a special interest. Such a communication brings to the present some of the atmosphere of three centuries ago, and hence is not without interest. It reads as follows:

Monsieur,

I was recently surprised at the departure of Monseigneur the Archdeacon, for he had promised me that he would go to see you. Nevertheless I did not venture to delay this departure for the purpose of writing to you. Even now I have come very near failing in my duty of sending a few words to you, along with five or six lines which I have just written to Mons. Luillier. This delay has been due to the hope of having the fortune of writing more fully by the next post. I am still waiting to observe the eclipse. *Yesterday there began some evidence of a spot on the sun, and of this I have observed the position.* I shall also take further observations on the succeeding days for the purpose of comparing it further with the moon's shadow *at the time of the eclipse,* since at that time *it will have completed only two thirds of its path over the disk of the sun.* If you wish to see it, *it is quite large* and we shall be able to speak of it sometime hereafter. If another spot appears between now and then, I shall be on the watch.

Meanwhile I kiss very humbly your hands and remain always, Monsieur, your very humble, very affectionate, and very obliged servant,

GASSENDI

Digne, August 2,
——xxxiii.

The letter gives evidence of the state of astronomy in the days when the telescope was new and imperfect and when it was only just beginning to be successfully applied to observations upon which mathematical calculations could be based for the purpose of developing the theory of celestial mechanics.

17. A Letter from Bouillaud to Hevelius, 1666.

Among my autograph letters of the seventeenth century, one of the most interesting was written by Bouillaud to Hevelius. Few more attractive mathematical portraits exist than the one of Bouillaud painted from life by Jacob Van Schappen. It is a genuine work of art, and one has but to look upon it to feel that here is the face of a scholar. Ismael Bouillaud was born at Loudun in 1605 and died at Paris in 1694. He was one of the most staunch supporters of the Copernican system and was a man of great erudition. He wrote several treatises on astronomy, translated the arithmetic (theory of numbers) of Theon of Smyrna, and published a work on spirals. He was therefore interested in pure as well as applied mathematics. This letter is written to Johannes Hevelius, the well-known astronomer of Danzig. Hevelius, or Höwelke, was six years younger than Bouillaud and died in 1687. From 1641 until his death he devoted himself to astronomy, making his own somewhat primitive telescopes and setting them up in his private observatory.

Bouillaud's letter is interesting for several reasons, but chiefly for its reference to various contemporary astronomers, to some of the work then being undertaken, and to the general question of telescopes. On the last of these subjects Hevelius held very radical opinions, believing that for accuracy in the location of heavenly bodies the old pin-hole method was better.

Bouillaud wrote in Latin, according to the custom of the time, and in a legible

hand,—which was by no means a part of this custom.   In the letter he refers to the observations made by Hevelius and to a comet that had recently appeared. As to the latter he remarks that

> The path of the comet can be limited and determined by the observations made by you and the illustrious Domenico Cassini.

This is Giovanni Domenico (Jean-Dominique) Cassini, then in Bologna, who was just publishing his *Opera astronomica* (Rome, 1666).   In the same year the French statesman, Colbert, founded the Académie des Sciences and invited Cassini to Paris.   The invitation led to a visit to France and to a brief sojourn there; but not until 1669 did Cassini take up his permanent residence in the French capital.   The letter continues:

> As to the matters which may be open to dispute, pro and contra, with respect to the apparent size of the head of the new star, men will maintain uncertain judgments because of the very different conditions of their observations and because of the varying degrees of accuracy and perfection of the different telescopes.

It will be recalled that it was not until 1610 that Galileo discovered the satellites of Jupiter and that only in 1663 did Gregory publish his plan for using a concave mirror in a telescope, although Descartes and Mersenne had corresponded on the subject long before, and the latter had published his ideas in 1651. Hevelius had even maintained, as already stated, that telescopes were not sufficiently perfected for accurate observations of position.   Achromatic lenses were still a long way in the future, and Bouillaud's letter shows that the instrument itself was still in its infancy.   He continues, referring to a letter on the subject written by Hevelius on December 5, 1665:

> Since in your letter you make mention of telescopes, it will doubtless please you to know from me what has been written about the instruments made in Rome and Florence by that very skilled and famous artisan Joseph Campanus [Giuseppe Campano].   By the aid of these telescopes they have observed not only the satellites of Jupiter in the disc of the planet but also the revolution of the planet about its own axis, which is completed in about ten hours.   By reason of the fitness and advantages of their location and the necessary resources for meeting the expenses of carrying out and accomplishing these things, we who are in Paris and are perfectly capable of making observations, but are without due support in the matter, are anticipated by others and the glory is taken away from us.   That most illustrious Domenico Cassini has made public his observations in three letters written to a friend, and these you can obtain from our friend De Noyer and also from our friend Burattino, to whom I believe they have been sent from Italy.

The Campano mentioned was a famous maker of instruments, and the Cassini was the first of the four astronomers of this family in the Royal Observatory of Paris.

The Latin beginning and ending may be interesting to readers who have given little attention to the epistolary style of the time.   The letter begins:

> Amplissimo Viro Dnō Io. Heuelio Veteris Gedani Consuli Ismael Bullialdus S. P. D.
> To that most learned man, Lord Johannes Hevelius, Councilor of the ancient Gedanum [Danzig], Ismael Bouillaud, Salutem Plurimam Dicit.

It closes:

> Vale Vir Amplissime & me semper ama. Scribeb. Lutetiae Parisioᷓ die 15. Ianuarii 1666.
> Farewell, most learned man, and always have regard for me.   Written in Paris the 15th day of January, 1666 [old style].